under the stacked gate structures, each part of the first insulating film which is left behind under the stacked gate structures acting as a first gate insulating film;

forming a post oxidation film on side walls and upper surfaces of the stacked gate structures and the exposed main surface of the semiconductor substrate by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C;

A2 cont'd

oxynitrifying the post oxidation film; and

doping impurity into the main surface of the semiconductor substrate with the stacked gate structures used as a mask to form source and drain regions.

REMARKS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 1-4, 7, 10, 12-18, 20 and 22 are pending in the present application. Claims 5, 6, 8, 9, 11, 19 and 21 have been canceled and Claims 1-4, 7, 10, 12-18, 20 and 22 have been amended by the present amendment.

In the outstanding Office Action, Claims 1 and 4 were rejected under 35 U.S.C. § 102(e) as anticipated by Gardener et al (U.S. Patent No. 6,127,251); Claims 2-3 and 6-8 were rejected under 35 U.S.C. § 103(a) as unpatentable over Gardener et al '251 in view of Rama et al; Claims 5 and 9 were rejected under 35 U.S.C. § 103(a) as unpatentable over Gardener et al '251 in view of Jeong; and Claims 10-22 were rejected under 35 U.S.C. § 103(a) as unpatentable over Gardener et al '251 in view of Rama et al and Gardener et al (U.S. Patent No. 6,252,283).

Claim 1 has been amended to include subject matter similar to that recited in Claim 5. Accordingly, the rejection of Claims 1 and 4 under 35 U.S.C. § 102(e) as anticipated by Gardener et al is moot.

Claims 2-3 and 6-8 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Gardener et al '251 in view of Rama et al. This rejection is respectfully traversed.

As noted above, Claim 1 has been amended to include subject matter similar to that recited in Claim 5. In more detail, the present invention as recited in Claim 1 is directed to semiconductor device manufacturing method in which a gate insulating film is removed except under gate electrodes to expose the main surface of a semiconductor substrate, and an insulation film is formed on the exposed main surface of the semiconductor substrate by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C. Further, impurity diffused layers are formed on both sides of the respective gate electrodes in the semiconductor substrate.

For example, as shown in Figure 5H, the gate insulating film 13 is removed except under the gate electrodes 14 to expose the main surface of the semiconductor substrate 11. In addition, an insulating film 19 is formed on the exposed main surface of the semiconductor substrate 11 by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C. Impurity diffused layers 20 are formed on both sides of the respective gate electrodes in the semiconductor substrate 11.

According to the claimed invention, the negative effects of nitrogen contained in a gate insulating film near the edge portion of the gate electrode after the gate electrode is processed (after the impurity diffused layer is formed) when an oxynitride is used as a gate insulating film is reduced. In other words, the present invention relates to a post oxidation

step. In addition, as shown in Figure 6, because an edge portion 14A of the floating gate 14 used as a first gate electrode which lies on the tunnel oxide film (oxynitride film 13) side can be rounded, concentration of an electric field can be suppressed (see page 20, lines 2-7).

The outstanding Office Action states Gardener et al '251 reveals a device by forming a gate insulating film 18 made of oxynitride on the main surface of the substrate 12 followed by forming gate electrodes 20 on the film layer, with diffused layers on both sides of the gate electrodes 38 and the partial removal of the gate insulating film 19. However, Applicants note Gardener et al '251 do not teach or suggest the step of forming an insulating film (post oxidation film) on the impurity diffused layers as recited in amended Claim 1.

Rather, in Gardener et al '251, an air gap 29 is formed beneath a gate conductor 15 and side wall spacers 27 are formed on the side wall of the gate conductor 15 by a conformal deposition. Because Gardener et al '251 do not use a strong oxidation process such as a vaporizer method, an oxyhydrogen combustion method, or a wet oxidation method performed at temperatures not lower than 950°C, the edge portion of the gate conductor 15 cannot be rounded, unlike the present invention. Therefore, the electric field in Gardener et al '251 cannot be suppressed.

The outstanding Office Action also states Rama et al includes a process where the substrates are essentially oxidized two times, one thermally and the other by a vapor method. However, Applicants note Rama et al use NO oxynitride when candidate gate dielectrics and tunnel dielectrics for a submicron device are formed. More specifically, a thermal oxide is first grown and then NO oxynitride is grown by annealing the oxide in a NO ambient. That is, Rama et al is directed to forming a gate insulating film itself.

On the contrary, the present invention relates to a technique for reducing negative effects of nitrogen contained in a gate insulating film near the edge portion of the gate

electrode after the gate electrode is processed (after the impurity diffused layer is performed) when an oxynitride is used as a gate insulating film, as noted above. That is, the present invention relates to a post oxidation step.

Further, Claim 7 is directed to nitrifying the insulating film. More specifically, the object to be nitrided is the insulating film (post oxidation film) on the impurity diffused layer but not the gate insulating film. Neither Gardener et al nor Rama et al teach or suggest this feature. In addition, it appears the outstanding Office Action considers the vapor process described in Rama et al as being the same as the vaporized method according to the present invention. However, these methods are different because the vaporizer method uses a gas generated by a vaporizer.

Accordingly, in light of the above comments, it is respectfully submitted independent Claim 1 and each of the claims depending therefrom define over Gardener et al and Rama et al.

Claims 5 and 9 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Gardener et al in view of Jeong. This rejection is respectfully traversed.

Claims 5 and 9 depend on Claim 1, which as discussed above is believed to be allowable. Further, it is respectfully submitted Jeong also do not teach or suggest the features recited in independent Claim 1. Therefore, it is respectfully requested this rejection also be withdrawn.

Claims 10-22 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Gardener et al '251 in view of Rama et al and Gardener et al '283. This rejection is respectfully traversed.

Independent Claims 10, 12, 13, 20 and 22 also includes features similar to that recited in independent Claim 1. As discussed above, Gardener et al '251 and Rama et al do not teach

or suggest the features recited therein. Further, Gardener et al '283 discloses an example of changing the profile of N, for example, by changing the energy of ion implantation, film thickness or the material of a gate electrode. However, Gardener et al '283 is completely silent about changing the profile of N using at least one of a vaporizing method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C as recited in amended Claims 10 and 20. In addition, Gardener et al '283 do not teach or suggest forming a post oxidation film (or a fourth insulating film) using at least one of a vaporizing method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C as recited in amended independent Claims 12, 13 and 22.

Accordingly, it is respectfully requested this rejection also be withdrawn.

In addition, the specification has been amended to correspond with changes made to the claims and to correct minor informalities. Applicants submit no new matter has been ✓ added.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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IN THE SPECIFICATION

Please delete the BRIEF SUMMARY OF THE INVENTION in its entirety at page 6, line 2 to page 14, line 20 in its entirety and substitute therefor:

--According to an aspect of the present invention, there is provided a semiconductor device manufacturing method comprising forming a gate insulating film in an oxynitride form on a main surface of a semiconductor substrate; forming gate electrodes on the gate insulating film; removing the gate insulating film except under the gate electrodes to expose the main surface of the semiconductor substrate; forming an insulating film on the exposed main surface of the semiconductor substrate by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C; and forming impurity diffused layers on both sides of the respective gate electrodes in the semiconductor substrate.

According to another aspect of the present invention, there is provided a semiconductor device manufacturing method comprising forming a gate insulating film in an oxynitride form on a main surface of a semiconductor substrate; forming gate electrodes on the gate insulating film; making a nitrogen concentration of the gate insulating film except under the gate electrodes lower than a nitrogen concentration of the gate insulating film which lies under the gate electrodes by oxidizing the gate electrodes and the gate insulating film by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet

oxidation method performed at temperatures not lower than 950°C; and forming impurity diffused layers on both sides of the respective gate electrodes in the semiconductor substrate.

According to still another aspect of the present invention, there is provided a semiconductor device manufacturing method comprising forming a gate insulating film in an oxynitride form on a main surface of a semiconductor substrate; forming gate electrodes on the gate insulating film; forming a post oxidation film on the main surface of the semiconductor substrate except under the gate electrodes by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C; oxynitrifying the post oxidation film, and forming impurity diffused layers on both sides of the respective gate electrodes in the semiconductor substrate.

According to still another aspect of the present invention, there is provided a semiconductor device manufacturing method comprising forming a first insulating film in an oxynitride form on a main surface of a semiconductor substrate; forming a first conductive layer on the first insulating film; forming a second insulating film on the first conductive layer; forming a second conductive layer on the second insulating film; forming a third insulating film on the second conductive layer; patterning the third insulating film to form a mask; etching the second conductive layer, second insulating film and first conductive layer with the third insulating film used as a mask to form stacked gate structures each having a control gate, second gate insulating film and floating gate; removing part of the first insulating film which lies on the main surface of the semiconductor substrate and is disposed between the stacked gate structures to expose the main surface of the semiconductor substrate and leave another part of the first insulating film which lies under the stacked gate structures, each part of the first insulating film which is left behind under the stacked gate structures

acting as a first gate insulating film; forming a fourth insulating film on side walls and upper surfaces of the stacked gate structures and the exposed main surface of the semiconductor substrate by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C; and doping impurity into the main surface of the semiconductor substrate with the stacked gate structures used as a mask to form source and drain regions.

According to still another aspect of the present invention, there is provided a semiconductor device manufacturing method comprising forming a first insulating film in an oxynitride form on a main surface of a semiconductor substrate; forming a first conductive layer on the first insulating film; forming a second insulating film on the first conductive layer; forming a second conductive layer on the second insulating film; forming a third insulating film on the second conductive layer; patterning the third insulating film to form a mask; etching the second conductive layer, second insulating film and first conductive layer with the third insulating film used as a mask to form stacked gate structures each having a control gate, second gate insulating film and floating gate, each part of the first insulating film which lies under the stacked gate structures acting as a first gate insulating film; making a nitrogen concentration of the first insulating film which is disposed between the respective stacked gate structures lower than a nitrogen concentration of the first insulating film which lies under the stacked gate structures by oxidizing the stacked gate structures and the first gate insulating film disposed between the respective stacked gate structures by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C; and doping impurity into the main surface of the semiconductor substrate with the stacked gate structures used as a mask to form source and drain regions.

According to still another aspect of the present invention, there is provided a semiconductor device manufacturing method comprising forming a first insulating film in an oxynitride form on a main surface of a semiconductor substrate; forming a first conductive layer on the first insulating film; forming a second insulating film on the first conductive layer; forming a second conductive layer on the second insulating film; forming a third insulating film on the second conductive layer; patterning the third insulating film to form a mask; etching the second conductive layer, second insulating film and first conductive layer with the third insulating film used as a mask to form stacked gate structures each having a control gate, second gate insulating film and floating gate; removing part of the first insulating film which lies on the main surface of the semiconductor substrate and is disposed between the stacked gate structures to expose the main surface of the semiconductor substrate and leave another part of the first insulating film under the stacked gate structures, each part of the first insulating film which is left behind under the stacked gate structures acting as a first gate insulating film; forming a post oxidation film on side walls and upper surfaces of the stacked gate structures and the exposed main surface of the semiconductor substrate by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C; oxynitrifying the post oxidation film; and doping impurity into the main surface of the semiconductor substrate with the stacked gate structures used as a mask to form source and drain regions.--

Please delete the paragraph at page 14, line 21 to page 15, line 1 in its entirety.

[The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.]

Please replace the paragraph at page 32, lines 3-13, as follows:

--As described above, according to the embodiments of this invention, it is possible to provide a semiconductor device manufacturing method capable of preventing that electrons are trapped in the gate insulating film to reduce a current amount or the electric field is concentrated on part of the gate insulating film to accelerate deterioration thereof by the presence of damage of the gate insulating film caused at the time of processing of the gate electrodes in a case where a thermal nitride film is used as the gate insulating film.--

IN THE CLAIMS

Claims 5, 6, 8, 9, 11, 19 and 21 (Canceled).

--1. (Amended) A semiconductor device manufacturing method comprising [the steps of]:

forming a gate insulating film in an oxynitride form on a main surface of a semiconductor substrate;

forming gate electrodes on the gate insulating film;

[forming impurity diffused layers on both sides of the respective gate electrodes in the semiconductor substrate; and]

removing [part of] the gate insulating film [which lies on the impurity diffused layers] except under the gate electrodes to expose the main surface of the semiconductor substrate;

forming an insulating film on the exposed main surface of the semiconductor substrate by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C; and

forming impurity diffused layers on both sides of the respective gate electrodes in the semiconductor substrate.

2. (Amended) The semiconductor device manufacturing method according to claim 1, wherein said [step of] forming the gate insulating film includes [steps of] thermally oxidizing the main surface of the semiconductor substrate to form an oxide film, nitrifying the oxide film, and oxidizing the nitrified oxide film again.

3. (Amended) The semiconductor device manufacturing method according to claim 1, wherein said [step of] removing [part of] the gate insulating film <u>except under the gate electrodes</u> [which lies on the impurity diffused layers] is effected by using at least one of hot phosphoric acid, a mixed solution of hydrofluoric acid and glycerol, a mixed solution of hydrofluoric acid and ethylene glycol, a mixed solution of hydrofluoric acid and ethylene glycol mono-ethyl ether and hydrofluoric acid vapor.

4. (Amended) The semiconductor device manufacturing method according to claim 1, wherein said [step of] removing [part of] the gate insulating film <u>except under the gate electrodes</u> [which lies on the impurity diffused layers] is effected by use of an isotropic etching process.

7. (Amended) The semiconductor device manufacturing method according to claim [6] <u>1</u>, further comprising [a step of] nitrifying the <u>insulating</u> [post oxidation] film.

10. (Amended) A semiconductor device manufacturing method comprising [the steps of]:

forming a gate insulating film in an oxynitride form on a main surface of a semiconductor substrate;

forming gate electrodes on the gate insulating film;

[forming impurity diffused layers on both sides of the respective gate electrodes in the semiconductor substrate; and]

making a nitrogen concentration of part of the gate insulating film except under the gate electrodes [which lies on the impurity diffused layers] lower than a nitrogen concentration of part of the gate insulating film which lies under the gate electrodes by oxidizing the gate electrodes and the gate insulating film [impurity diffused layers] by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C.

12. (Amended) A semiconductor device manufacturing method comprising [the steps of]:

forming a gate insulating film in an oxynitride form on a main surface of a semiconductor substrate;

forming gate electrodes on the gate insulating film;

[forming impurity diffused layers on both sides of the respective gate electrodes in the semiconductor substrate;]

forming a post oxidation film on the main surface of the semiconductor substrate [the impurity diffused layers] except under the gate electrodes by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C; [and]

oxynitrifying the post oxidation film; and

forming impurity diffused layers on both sides of the respective gate electrodes in the semiconductor substrate.

13. (Amended) A semiconductor device manufacturing method comprising [the steps of]:

forming a first insulating film in an oxynitride form on a main surface of a semiconductor substrate;

forming a first conductive layer on the first insulating film;

forming a second insulating film on the first conductive layer;

forming a second conductive layer on the second insulating film;

forming a third insulating film on the second conductive layer;

patterning the third insulating film to form a mask;

etching the second conductive layer, second insulating film and first conductive layer with the third insulating film used as a mask to form stacked gate structures each having a control gate, second gate insulating film and floating gate;

removing part of the first insulating film which lies on the main surface of the semiconductor substrate and is disposed between the stacked gate structures to expose the main surface of the semiconductor substrate and leave another part of the first insulating film which lies under the stacked gate structures, each part of the first insulating film which is left behind under the stacked gate structures acting as a first gate insulating film;

forming a fourth insulating film on side walls and upper surfaces of the stacked gate structures and the exposed main surface of the semiconductor substrate by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C; and

doping impurity into the main surface of the semiconductor substrate with the stacked gate structures used as a mask to form source and drain regions.

14. (Amended) The semiconductor device manufacturing method according to claim 13, wherein said [step of] forming the first insulating film includes [steps of] thermally oxidizing the main surface of the semiconductor substrate to form an oxide film, nitrifying the oxide film, and oxidizing the nitrified oxide film again.

15. (Amended) The semiconductor device manufacturing method according to claim 13, wherein said [step of] removing part of the first insulating film is effected by using at least one of hot phosphoric acid, a mixed solution of hydrofluoric acid and glycerol, a mixed solution of hydrofluoric acid and ethylene glycol, a mixed solution of hydrofluoric acid and ethylene glycol mono-ethyl ether and hydrofluoric acid vapor.

16. (Amended) The semiconductor device manufacturing method according to claim 13, wherein said [step of] removing part of the first insulating film which is effected by use of an isotropic etching process.

17. (Amended) The semiconductor device manufacturing method according to claim 13, wherein said [step of] forming the fourth insulating film includes [a step of] forming oxide films on the side walls and upper surfaces of the stacked gate structures and the exposed main surface of the semiconductor substrate [by use of a thermal oxidation method].

18. (Amended) The semiconductor device manufacturing method according to claim 13, wherein said [step of] forming the fourth insulating film includes [steps of] forming oxide films on the side walls and upper surfaces of the stacked gate structures and the exposed main surface of the semiconductor substrate [by use of a thermal oxidation method], nitrifying the oxide film, and oxidizing the nitrified oxide film again.

20. (Amended) A semiconductor device manufacturing method comprising [the steps of]:

forming a first insulating film in an oxynitride form on a main surface of a semiconductor substrate;

forming a first conductive layer on the first insulating film;

forming a second insulating film on the first conductive layer;

forming a second conductive layer on the second insulating film;

forming a third insulating film on the second conductive layer;

patterning the third insulating film to form a mask;

etching the second conductive layer, second insulating film and first conductive layer with the third insulating film used as a mask to form stacked gate structures each having a control gate, second gate insulating film and floating gate, each part of the first insulating film which lies under the stacked gate structures acting as a first gate insulating film;

[removing part of the first insulating film which lies on the main surface of the semiconductor substrate and is disposed between the stacked gate structures to expose the main surface of the semiconductor substrate and leave another part of the first insulating film which lies under the stacked gate structures, each part of the first insulating film which is left behind under the stacked gate structures acting as a first gate insulating film;

doping impurity into the main surface of the semiconductor substrate with the stacked gate structures used as a mask to form source and drain regions; and]

making a nitrogen concentration of [part of] the first [gate] insulating film which [lies on the impurity diffused layers] is disposed between the respective stacked gate structures lower than a nitrogen concentration of [part of] the first [gate] insulating film which lies under the stacked gate structures by oxidizing the stacked gate structures and the first insulating film disposed between the respective stacked gate structures [the impurity diffused layers] by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C; and

doping impurity into the main surface of the semiconductor substrate with the stacked gate structures used as a mask to form source and drain regions.

22. (Amended) A semiconductor device manufacturing method comprising [the steps of]:

forming a first insulating film in an oxynitride form on a main surface of a semiconductor substrate;

forming a first conductive layer on the first insulating film;

forming a second insulating film on the first conductive layer;

forming a second conductive layer on the second insulating film;

forming a third insulating film on the second conductive layer;

patterning the third insulating film to form a mask;

etching the second conductive layer, second insulating film and first conductive layer with the third insulating film used as a mask to form stacked gate structures each having a control gate, second gate insulating film and floating gate;

removing part of the first insulating film which lies on the main surface of the semiconductor substrate and is disposed between the stacked gate structures to expose the main surface of the semiconductor substrate and leave another part of the first insulating film under the stacked gate structures, each part of the first insulating film which is left behind under the stacked gate structures acting as a first gate insulating film;

forming a post oxidation film on side walls and upper surfaces of the stacked gate structures and the exposed main surface of the <u>semiconductor</u> [silicon] substrate <u>by at least one of a vaporizer method, an oxyhydrogen combustion method, and a wet oxidation method performed at temperatures not lower than 950°C</u>;

oxynitrifying the post oxidation film; and

doping impurity into the main surface of the semiconductor substrate with the stacked gate structures used as a mask to form source and drain regions.--